LED MEASUREMENT INSTRUMENTATION

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The production and use of LEDs is increasing rapidly. They are being used in applications previously occupied by traditional lighting components such as incandescent lamps, as well as indicators, signs, displays and new lighting developments. Measurements of LED devices are required so that performance can be assessed, both in relation to other LED devices and as replacements for existing applications. These measurements must be consistent across the industry to ensure comparisons are valid.

LEDs come in many packages, often with integral lenses, diffusers or phosphors that alter the angular distribution and spectral emission properties. A measurement setup that gives accurate results on one LED may be inappropriate for testing a different package type. A one setup measures all approach can lead to discrepancies within the industry, yet the test equipment must be necessarily kept simple and general for any meaningful comparison to take place. Emphasis will therefore be placed on factors that lead to major disagreements between measurements of the same optical quantities. Hopefully, by controlling these factors some consensus on standard measurement protocols can be reached.

Traditionally, optical quantities such as luminous intensity, luminous flux, radiant intensity, radiant flux, peak and dominant wavelength, kurtosis, chromaticity coordinates, efficacy and efficiency might be used to assess the LED. With LEDs competing in traditional lighting and display applications however, the requirement for other measurements such as illuminance, luminance and color rendering properties increases. Some of these quantities can vary with angle, and goniometric measurements may also be required.

Whether a spectroradiometer, photometer or radiometer is used in measurement, it is the input optic that determines the **type** of quantity measured. For instance, if an LED is placed in an integrating sphere: a spectroradiometer will measure total spectral flux; a photometer will measure total luminous flux; and a radiometer will measure total radiant flux. Different input optics are required for measurements of total luminous flux, 2π luminous flux , luminous intensity, luminance and illuminance. Measurements of the radiometric and spectroradiometric equivalents would generally use the same or similar input optics to those for these luminous quantities.

Details of the input optic design for luminous intensity, luminance, illuminance, total luminous flux and 2π luminous flux , will be discussed, including:

1. What is to be measured? Definitions and geometries.
2. Do LEDs fit these geometries? Some practical definitions and discussions.
3. Sources of error and disagreements between LED measurement systems.